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Note by the Secretary-General

The Secretary-General has the honour to transmit to the Security Council the twenty-first quarterly report on the activities of the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC) (see annex). It is submitted by the Acting Executive Chairman of UNMOVIC in accordance with paragraph 12 of Security Council resolution 1284 (1999) of 17 December 1999.

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Annex

Twenty-first quarterly report on the activities of the United Nations Monitoring, Verification and Inspection Commission in accordance with paragraph 12 of Security Council resolution 1284 (1999)

I. Introduction

1. The present report, which is the twenty-first[a] submitted in accordance with paragraph 12 of Security Council resolution 1284 (1999), covers the activities of the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC) during the period from 1 March to 31 May 2005.

II. Developments

2. During the period under review, the Acting Executive Chairman has continued the practice of briefing the respective Presidents of the Security Council, representatives of Member States and officials of the Secretariat on the activities of UNMOVIC.

Status of sites, dual-use equipment and materials subject to monitoring

3. The Commission's previous report (S/2005/129) mentioned that UNMOVIC had contacted Iraq's neighbours to determine whether dual-use items subject to monitoring had found their way into or through their countries. Of the two remaining Governments from which a response had been awaited, the Government of the Islamic Republic of Iran informed UNMOVIC on 14 March that after a thorough investigation by the various authorities and relevant organizations, the Government had concluded that no scrap had found its way into or through scrap yards in Iran. No response has been received so far from the Government of Saudi Arabia.

4. UNMOVIC imagery analysts have continued the ongoing review of the status of sites subject to inspection and monitoring in Iraq. Of the 411 sites inspected in the period from November 2002 to March 2003, Commission experts have acquired and examined post-war high-resolution imagery covering 378 sites, including those considered the most important. As part of the continuing examination and analysis, experts have determined to date that 109 of the sites (of which 90 had been identified in the Commission's previous report) were cleaned to varying degrees. Further analysis revealed that dual-use equipment and materials subject to monitoring have been removed totally from 52 sites, and partially from 44 sites which suffered less damage. Additionally, at 13 sites, some equipment and materials that were stored in the open have been removed. No conclusion can be drawn concerning the presence or absence of equipment or materials inside undamaged buildings, nor the destination of all items removed.

[a] The Commission's 20 previous reports were issued as documents S/2000/516, S/2000/835, S/2000/1134, S/2001/177, S/2001/515, S/2001/833, S/2001/1126, S/2002/195, S/2002/606, S/2002/981, S/2002/1303, S/2003/232, S/2003/580, S/2003/844, S/2003/1135, S/2004/160, S/2004/435, S/2004/693, S/2004/924 and S/2005/129.

5. Approximately 7,900 items of dual-use equipment and material (130 biological, 4,780 chemical and 3,000 missile-related) covered by the UNMOVIC plan for ongoing monitoring and verification and the export/import monitoring mechanism were known to have been located among the 109 sites through declarations by Iraq and UNMOVIC inspections. Significant quantities of dual-use raw material were also known to have been present at those sites. From the imagery analysis UNMOVIC has concluded that biological sites were less damaged (only 12 of the 109 are biological sites). The fact that such facilities are generally smaller-sized units and were probably better protected through local security arrangements may account for the lesser damage and the smaller numbers of equipment and items removed from them.

6. Dual-use equipment and materials like those removed from sites in Iraq can be used for legitimate purposes. However, they can also be utilized for prohibited purposes if in a good state of repair and integrated in a production line in a suitable environment. Some of the most significant dual-use equipment removed from the 109 sites currently under review is addressed in the following tables with respect to its categories, numbers and utilities.

Table 1
Biological-related equipment

Items	*Number removed versus total recorded in Iraq*	*Comments*
Biosafety cabinets/glove boxes	14 of 259 (5%)	Equipment for handling micro-organisms.
Shaker incubators	7 of 71 (10%)	Laboratory and small-scale production sizes.
Fermenters, bioreactors and jacketed tanks	37 of 405 (9%)	Range in size from a few litres to about 5,000 litres, many old or in various states of repair.
Centrifuges, separators, decanters, filter presses	17 of 187 (9%)	Downstream processing equipment not used for bulk agent production in the past biological warfare programme. Includes some small laboratory or bench-top centrifuges.
Spray, freeze and drum driers	12 of 190 (6%)	Varying sizes but many small bench-top models for research and development.

7. One of the biological-related sites which suffered major damage was Ibn Al Baytar, a research, development and pilot production scale facility for pharmaceutical products. Of the other sites, the most significant included Fallujah III and the Rasheed military complex (hospital, laboratory and stores).

8. The equipment at the sites mentioned in the preceding paragraph and table 1 included a full range of fermentation vessels from laboratory scale (8 litres) to full production scale (5,000 litres) as well as preparation and downstream processing equipment such as biosafety cabinets and freeze dryers. The state of repair of this equipment, however, varied considerably from good working order to a poor state which meant that it could be refurbished only at high cost.

Table 2
Chemical-related equipment

Items	*Number removed versus total recorded in Iraq*	*Comments*
Reactor vessels	53 of 98 (54%)	Equipment to conduct wide range of chemical reactions; due to its characteristics, this equipment can be used for the production of both commercial chemicals and chemical warfare agents and their precursors.
Heat exchangers/ condensers	142 of 310 (45%)	Important parts of chemical installations, complementary to reactors in chemical processes; essential for quality and safety.
Distillation/absorption columns	173 of 272 (63%)	
Scrubbers and separators	14 of 28 (50%)	
Storage tanks and vessels	286 of 1,217 (24%)	Usually used as feeding tanks for starting materials and for final product storage, intermediate and long-term. Those made of fibreglass also have various other common applications such as water or sewage tanks.

9. In addition, other dual-use equipment and items such as 628 metal sheets of Monel and Inconel, 3,380 valves, 107 pumps and over 13 kilometres of pipes were known to have been located among the chemical sites of relevance. The Qaa Qaa industrial complex was among the sites possessing the greatest quantity of dual-use production equipment, whose fate is now unknown. Of all the items listed above, one third had been used at the complex. Another significant portion of such items was located at the Fallujah II and Fallujah III facilities. Spare parts and raw materials were stored at the Khan Dari Stores belonging to the Ibn Yunis Research Centre.

10. The sites mentioned in the preceding paragraph possessed dual-use equipment of all types and characteristics. The equipment was constructed of material considered as most relevant for chemical warfare-related purposes. It included reactors with volumes between 100 and 3,000 litres, heat exchangers, distillation columns and other parts adjusted to that volume range. Most of the equipment was in working condition and operational.

Table 3
Missile-related equipment and materials

Items	*Number removed versus total recorded in Iraq*	*Comments*
Solid propellant production equipment	94 of 132 (71%)	Mixers, grinders, casting chambers, kneading machines, extrusion presses, curing ovens, etc.
Missile hardware production equipment	289 of 340 (85%)	Flow-forming and hot spinning machines, vacuum furnaces, computer numerically controlled/ multi-axis milling and turning machines and other equipment such as welding machines, presses, moulds, etc.
Testing equipment	85 of 169 (50%)	Test equipment for liquid propellant missile subsystems, three-dimensional measurement machines, balancing machines for turbo-pumps, equipment for static motor/engine firing tests, test equipment for guidance, navigation and control systems, and other test equipment such as X-ray machines, hydrostatic pressure test equipment, etc.
Missile subsystems and components	1,453 of 1,611 (90%)	Including liquid propellant engines, guidance, navigation and control items and other parts such as air bottles, SA-2 batteries, pressure-reducing valves, etc.
Raw materials	573 of 637 metric tons (90%)	Including ammonium perchlorate, aluminium powder, hydroxy-terminated polybutadiene (HTPB), ethylene propylene diene monomer (EPDM), maraging steel, etc.

11. Of the 109 sites analysed from satellite imagery and determined to have been cleaned to some degree, 58 had been under monitoring for missile activities. The 58 sites (containing equipment shown in table 3 above) include several of the key production sites for both solid and liquid propellant missiles. At these sites there were hundreds of additional pieces of less significant dual-use machinery, essentially of types found in any general engineering production facility or workshop.

12. At the Kadhimiya and Al Samoud factory sites, where airframes and engines for liquid propellant missiles were manufactured and final assembly work was carried out, all equipment and missile components have been removed. At the Fateh site, where similar production activities occurred, some of the equipment has been removed.

13. In relation to solid propellant missile production, all equipment has been removed from the Mutasim site, where final missile assembly and testing for Iraq's larger missiles were carried out. All equipment and raw materials were removed from the Mamoun site, where all solid propellant was produced. At the Tho Al Fekar factory, which also manufactured hardware components for missiles, all significant equipment was removed.

14. Essentially all items included in table 3 above were in working condition, with the exception of six (out of 12) flow-forming machines which were substantially damaged to various degrees.

Addenda to the comprehensive report of the Iraq Survey Group

15. On 25 April, Charles Duelfer, the Special Adviser to the Director of Central Intelligence of the United States of America, issued a series of addenda to his earlier comprehensive report of 2004 and released a revised version of the report with minor editing changes. A note accompanying the addenda states that they complete the record of the Special Adviser on Iraq's weapons of mass destruction, but that further information will become available over time. The Special Adviser also notes that "for now, the report is the best picture that could be drawn concerning the events, programmes, policies and underlying dynamics of the relationship of the former regime to weapons of mass destruction over the last three decades". However, he observes that substantial efforts continue to be made to examine documents that have been recovered from the former regime and that it will take several months at least to go through all remaining documents.

16. The report notes that site visits were terminated in November 2004 due to security concerns. There also continue to be reports of weapons of mass destruction in Iraq but the Iraq Survey Group has found that such reports are usually scams or result from the misidentification of materials or activities. In a very limited number of cases they have related to findings of old chemical munitions produced before 1990.

17. With respect to residual proliferation concerns, the accompanying note assesses that the risk of Iraqi expertise or material advancing the weapons of mass destruction potential in other countries is attenuated by many factors and is presently small but not to be ignored and that, so far, insurgent efforts to attain unconventional weapons have been limited and contained by coalition actions. Instances cited in the comprehensive report concerning the possible movement of

weapons of mass destruction or related materials from Iraq prior to the war remain unresolved. The possibility of discovering mobile biological warfare capability is assessed as still possible but very unlikely. If there were to be a surprise discovery in the future, the report underlines that it would most likely be in the biological weapons area since the signature and facilities for these efforts are small compared to other types of weapons of mass destruction.

18. From the standpoint of UNMOVIC, new information is presented on the organizational structure and functions of the Military Industrialization Commission of Iraq up to 2003, but most of this information has little impact on the status of Iraq's disarmament. The addenda do not change the previous assessment and comments made by UNMOVIC with regard to the comprehensive report of October 2004. Some information presented in the addenda differs in detail from information and documents UNMOVIC possesses. However, it appears that most of the information comes from interviews with individuals and is based mainly on their recollections. With respect to Iraq's programmes, UNMOVIC is in possession of comprehensive information, compiled on the basis of multiple sources of information, which will be presented in the UNMOVIC compendium (see paras. 20-22 below).

19. On the issue of the status of dual-use items and former weapons sites subject to monitoring, the limited assessments of the Iraq Survey Group provided in the addenda and statements to the media in March by the Deputy Minister of Industry of Iraq corroborate information already obtained by UNMOVIC through satellite imagery assessment.

Compendium

20. The Commission has continued its work on the compendium of Iraq's proscribed weapons and programmes. The first draft was compiled by UNMOVIC in March 2005, as foreshadowed in the Commission's twentieth report (S/2005/129). The draft attempts to provide a detailed technical description of Iraq's proscribed weapons and programmes with an emphasis on lessons that can be drawn from both the nature of the programmes and the experience gained in the process of their verification by United Nations inspectors.

21. All information resources available to the Commission have been used for the work on the compendium. These include various sets of declarations submitted by Iraq, reports of inspections conducted by both the United Nations Special Commission (UNSCOM) and UNMOVIC, notes of discussions and interviews with Iraqi personnel, documents provided by Iraq and those found independently by inspectors, including those originating from forensic computer exploitation and aerial imagery, and information provided to the Commission by Governments. The draft also builds on subject studies already completed by the Commission such as the Al Samoud-2 missile study, the UNMOVIC guide to Iraq's special weapons, the remotely piloted vehicle and unmanned aerial vehicle study, the guide to the Military Industrialization Commission of Iraq and the study of Iraq's procurement network. A number of these were summarized in appendices to previous quarterly reports on the activities of UNMOVIC.

22. The Commission continues its work on the harmonization of the draft of the compendium and the lessons that can be drawn from this work. Examples of such lessons on specific issues are outlined in the appendix to the present report.

III. Other activities

External technical expert panel review of the ongoing monitoring and verification plan (biological provisions)

23. The Commission's last report (S/2005/129) mentioned that the College of Commissioners had been briefed on the results of the expert panel review of the biological provisions of the ongoing monitoring and verification plan. As circumstances in Iraq have changed since 2003, and given advances in science and technology, UNMOVIC reviewed the methodology and process of monitoring dual-use biological facilities and related material. In November 2004, UNMOVIC convened a panel of external non-governmental technical experts (from Brazil, France, Germany, the United Kingdom of Great Britain and Northern Ireland and the United States of America) to conduct an independent review of the biological provisions and associated annex of the ongoing monitoring and verification plan. They were asked to review, from a technical basis, the appropriateness, applicability and logic of the provisions and annex as they now stand. The results of their review are set out below.

24. An underlying assumption of the panel's recommendations was that appropriate supporting national legislation would be in place. The panel suggested that Iraq could be assisted in the drafting and implementation of national legislation and compliance with international obligations as well as in the establishment of a good records and documentation system which would help the monitoring and verification process. The panel identified several fundamental criteria for its ongoing monitoring and verification review, including that the monitoring system should be transparent and unambiguous for all users (UNMOVIC, Iraqi personnel/Government and suppliers) to avoid confusion and foster a high degree of compliance.

25. The panel identified the following criteria to be the triggers for declarations under the monitoring plan:

(a) *Containment*: Sites or facilities, fixed or mobile, meeting the criteria of the World Health Organization (WHO) of high or maximum containment for work with human and animal pathogens, or with containment for working with plant diseases;

(b) *Activities*: Declaration of sites or facilities, fixed or mobile, with activities that encompass possession, storage, destruction and work with agents; any activity involving genetic modification of an agent or transfer of genetic elements from an agent; any activities involving the breeding of vectors of human, animal or plant diseases, or pests; activities involving micro-encapsulation of live micro-organisms or proteinaceous substances; biodefence activities; and any activities involving vaccination of humans against botulism, smallpox or anthrax. In addition, activities were to include the growth of agents in embryonated eggs, and aggregate production in equipment types and size not captured in the list of equipment and micro-organisms contained in the annex to the plan;

(c) *International transfer*: Transfers of agents and equipment;

(d) *Equipment*: The annex contains lists of equipment, materials and micro-organisms the possession or use of which would in itself trigger the need for a site or facility to submit a monitoring declaration. The current equipment list consists of

many entries that are described in most cases generically, i.e. any equipment that can perform a certain function or activity, with only examples listed. The panel recommended for reasons of transparency and practicality that all equipment be more clearly defined. It accepted that a number of items could be removed from monitoring. The panel identified several criteria as the basis for selecting equipment that should be part of an effective monitoring regime. It reviewed each entry of the equipment list and, in general, its recommendations in the equipment list were in broad agreement with those proposed by UNMOVIC experts. The list proposed by the panel, if adopted, would result in an equipment declaration that is more focused on production, downstream processing and dissemination;

(e) *Agents*: The panel developed criteria for inclusion of micro-organisms and toxins in the ongoing monitoring and verification plan with the aim of focusing on selected agents and eliminating shortcomings of the existing lengthy lists. The entries in these lists encompass many micro-organisms with low human pathogenicity, most animal and plant pathogens and a variety of simulants. The criteria defined and used by the panel are as follows: (i) biological agents and toxins known to have been effectively weaponized by Iraq but also reported in open sources to have been weaponized in other biological warfare programmes elsewhere; (ii) biological agents and toxins known to have been subject to attempts to weaponize; and (iii) biological agents and toxins relatively easy to weaponize because of their properties. The panel noted that the current threats had changed, especially in the plant pathogen area, where the perceived threat has changed from large-scale to small-scale attacks.

26. By applying the defined criteria, the panel developed a more concise and considerably shorter list. There is generally a close correlation between the panel's results and those of the UNMOVIC review.

27. The panel recommended that if there is an intention to include other biological agents capable of being developed as economic weapons, then certain animal pathogens should be included, as well as plant pathogens and some pests of high socio-economic importance.

IV. Other issues

Field offices

28. UNMOVIC retains a core staff of nine local nationals in Baghdad who maintain the existing offices, laboratories and other equipment at the Canal Hotel. During the reporting period, the local staff conducted a detailed inventory of UNMOVIC communication gear and equipment in the laboratories. Some communication equipment has been loaned to the United Nations Assistance Mission for Iraq (UNAMI) and much of the non-expendable equipment of UNMOVIC has been secured in containers.

29. The Cyprus field office provides for storage and limited maintenance of inspection and monitoring equipment, and could be used as a staging area for staff and logistics support should UNMOVIC activities resume in Iraq. Two experts visited the field office in April to check the serviceability and completeness of the equipment. While there, they conducted an orientation course for the field office staff in emergency response to hazardous materials. Six United Nations personnel

from the United Nations Peacekeeping Force in Cyprus (UNFICYP) also participated in this training. The field office shipped to Vienna detection and protective equipment necessary to support the multidisciplinary training course held there from 2 to 13 May. Whenever appropriate, the staff of the field office has continued to provide logistics support to UNFICYP and UNAMI.

Staffing

30. Core UNMOVIC staff in the Professional category at Headquarters at present total 50 weapons experts and other personnel drawn from 24 nationalities, nine of whom are women.

Technical visits, meetings and workshops

31. UNMOVIC experts participated in several international conferences during the period under review. Experts attended an international conference in the United Kingdom on chemical demilitarization, at which technology relevant to UNMOVIC was discussed. Two UNMOVIC technical specialists attended the Pittsburgh Conference in the United States of America early in March. The conference presented the latest techniques in biological and chemical detection and diagnostic methods. On behalf of UNMOVIC, a roster expert attended the International Conference on Biosafety and Biorisks held in Lyons (France) in March 2005, which was organized by the Center for Biosecurity and WHO. Another UNMOVIC roster expert attended a meeting of the New Defence Agenda bioterrorism reporting group held in Brussels in April 2005.

32. UNMOVIC carried out technical seminars in New York on new techniques in detection of early protein markers for chemical and biological agents. A consultant on government regulation of vaccine and biological product development presented aspects and procedures of inspecting and auditing biotechnology and vaccine facilities through paper audit, quality assurance verification and interviews.

33. Two UNMOVIC biological experts were invited to Japan to brief the Japanese Government and members of the scientific and technical community on UNMOVIC inspection activity, focusing on inspection methodology and possible implications for future United Nations or other verification regimes. Briefings and discussions took place over three days in March.

34. A number of UNMOVIC staff attended the Interphex exhibition in New York in April. The exhibition displays the latest developments in dual-use equipment and production techniques related primarily to the biological and pharmaceutical industries.

Training

35. During the reporting period, UNMOVIC conducted two training courses for its roster inspectors. The second enhanced missile course was held in Germany from 7 to 18 March. Sixteen experts from 14 countries participated in the course, whose objective was to develop practical skills for inspection and monitoring of dual-use production equipment and capabilities in the missile area. The course included familiarization visits to relevant facilities as well as a practical inspection exercise.

36. The second advanced multidisciplinary course was conducted in Austria from 2 to 13 May with 16 participants from 13 countries. Its objective was to enhance the

capabilities of multidisciplinary teams to carry out inspections of sites that had not been previously inspected. The course included a computer-based desktop simulation of inspections at chemical, biological and missile facilities. It also included a practical inspection exercise at a facility made available by the host Government.

37. The Commission is grateful to the Governments of Germany and Austria for their support for its recent training activities.

38. Since the first training course in July 2000, UNMOVIC has conducted 30 training courses, including seven basic and 11 advanced courses. These courses enabled the inspectors to assess requirements for the monitoring of a specific dual-use facility or technology and design appropriate inspection/monitoring regimes for such facilities using an optimum set of tools and procedures. Emphasis has recently been placed on multidisciplinary approaches to training and inspection.

39. In order to conduct its training, UNMOVIC has created specific programmes, study materials, manuals, handbooks and videos for various types of training; established a cadre of experienced instructors, mainly from its Headquarters staff; developed a unique set of training exercises and tutorials to develop and reinforce required inspectors' skills; identified and adapted a number of facilities worldwide suitable for training activities, including mock inspections, practical exercises and familiarization visits; and established administrative, logistical and supporting infrastructure for effective training.

V. College of Commissioners

40. On 11 March, Susan Burk (United States of America) informed the Secretary-General that she had been assigned new duties at the Department of State and therefore wished to tender her resignation as an UNMOVIC Commissioner with immediate effect. The Secretary-General appointed Stephen G. Rademaker (United States of America) as her successor on 23 May 2005.

41. The UNMOVIC College of Commissioners convened in New York for its nineteenth regular session on 24 and 25 May 2005. As on previous occasions, observers from the International Atomic Energy Agency and the Organization for the Prohibition of Chemical Weapons attended the session.

42. The Acting Executive Chairman briefed the Commissioners on the activities of UNMOVIC since their last meeting. Presentations were made to the College on the status of work related to "small quantities" of biological and chemical weapons material and on steps involved in the investigation of suspect biological locations (taking into consideration lessons learned from experience in Iraq).

43. The College welcomed the introductory statement by the Acting Executive Chairman. This dealt with work related to ongoing monitoring and verification and the possible need for monitoring in Iraq for end-use verification of dual-use items for a transitional period. The College also welcomed the extensive presentations by UNMOVIC staff on monitoring of small quantities of chemical and biological warfare agents and assessments of sites in the biological area. The College commended the considerable work being undertaken within the Commission and encouraged the continuation of this work, in particular relating to the compendium, training and additional studies concerning ongoing monitoring and verification.

44. The College took note of the fact that the work of the Iraq Survey Group in its search for weapons of mass destruction in Iraq seemed to have effectively come to an end with the publication in April of a revised version of the comprehensive report released by the Group in October 2004, and addenda thereto.

45. The College noted the statement of the Acting Executive Chairman that several significant questions relating to Iraq's disarmament remained. It expressed the hope that at the appropriate time the Security Council would address the question of how it would proceed with the confirmation of Iraq's disarmament. The College will continue to discuss proposals, including those made by outside bodies and organizations, concerning the future of the Commission, in particular such matters as any requirement for future ongoing monitoring and verification in Iraq, any requirement for monitoring imports and exports of dual-use items and any requirement for the retention of the Commission's expertise. The College acknowledged that these issues were for the Security Council to decide upon, as was the timing of any Security Council discussion.

46. It was tentatively decided to hold the next meeting of the College on 24 and 25 August.

47. In accordance with paragraph 5 of Security Council resolution 1284 (1999), the Commissioners were consulted on the contents of the present report.

Appendix

Examples of lessons learned in the course of the work on the compendium

Example 1 — Uncovering the scope of Iraq's work on the chemical warfare agent VX

1. In 1991, Iraq declared that it had carried out laboratory research on VX. By 1995, UNSCOM uncovered evidence that the scope of Iraq's activities on VX was much broader. Consequently, in 1996 Iraq declared the production of 3.9 metric tons of VX, the production of 60 metric tons of key VX precursors and the acquisition of some 650 metric tons of other precursors for the production of VX. Iraq also acknowledged that it had decided to conceal various aspects of its VX activities from UNSCOM and, in 1991, had unilaterally destroyed all VX and key precursors it had produced and some 150 metric tons of other precursors it had procured as well as documents and records relevant to VX.

2. Whether an earlier voluntary disclosure by Iraq of its work on VX could have contributed to fully clarifying this matter can only be the subject of speculation. However, it is obvious that the unilateral destruction, admitted by Iraq, prolonged the verification process, led to the elimination of physical evidence essential for complete verification and left serious uncertainties regarding the quantities of VX produced and its disposition. In 2002, due to these uncertainties, UNMOVIC identified the issue of VX as one of the remaining unresolved disarmament issues. In March 2003, it included this issue in the list of key remaining disarmament tasks (required under the terms of Security Council resolution 1284 (1999)). The Iraq Survey Group also reported that Iraq had not adequately explained and accounted for its VX production and weaponization.

3. The VX verification experience makes it clear that only a sophisticated verification system comprising various verification tools and techniques is capable of uncovering evidence of past undeclared activities. The verification of procurement data revealed the acquisition of large quantities of precursors by Iraq; document searches resulted in the discovery of some records on VX-related activities; interviews with Iraqi scientists and technicians helped to identify gaps in Iraq's declarations on VX; debriefings of defectors produced additional information on the weaponization of VX; information from former suppliers to Iraq helped to corroborate the procurement data; and sampling and analysis identified the presence of VX degradation products. All of the above in combination with on-site inspections led to the identification of the indisputable existence of undeclared activities related to VX.

4. The multidisciplinary verification approach also helped to uncover additional evidence on VX. In 1998, UNSCOM decided to re-examine through sampling and analysis unilaterally destroyed special warheads for Al Hussein missiles. This issue was important for all three verification areas, missile, chemical and biological, since it was linked to the determination of the total number of special missile warheads destroyed and their types and composition. Degradation products of VX were found on missile warhead fragments by one national laboratory. Iraq, however, disputed these analytical results. Later in 1998, other missile warhead fragments were sampled in Iraq. The samples were analysed by three national laboratories. All three laboratories reported the presence of a decontamination compound, and one

laboratory identified a possible degradation product of a nerve agent, but not necessarily VX.

5. Specific technical knowledge had been gained from the experience of sampling and analysis in the course of the VX investigation. One is that sampling and analysis should be performed at the earliest stages of verification and be considered as a routine procedure to collect more verification data rather than an extraordinary measure to verify specific concerns. It should be noted that traces of VX degradation products on chemical process equipment were found only in 1997, after VX production had been established and the specific production plant used by Iraq for that purpose had been identified. Special missile warhead fragments that had initially been verified in 1992 were finally subject to thorough sampling and analysis only in 1998. The following additional procedures for sampling and analysis were introduced by UNMOVIC in the light of this experience:

(a) Samples were to be independently analysed by at least two approved outside laboratories following existing chain-of-custody procedures;

(b) One portion of each sample was to be given to Iraq and another retained by UNMOVIC as a reference;

(c) All samples, as well as raw data and analytical results generated in the course of analyses by the outside laboratories, were to be the property of UNMOVIC;

(d) All conclusions and assessments of analytical results were to be the responsibility of UNMOVIC.

Example 2 — Missile monitoring

6. Under Security Council resolution 687 (1991), Iraq is prohibited from possessing ballistic missiles with a range greater than 150 kilometres. Thus, missiles remaining in Iraq that exceeded the limit set by the Security Council, as well as their major parts, repair and production facilities, were subject to destruction, removal or rendering harmless under international supervision. The plan for ongoing monitoring and verification approved by Security Council resolution 715 (1991) expanded the prohibition and applied it to any delivery system capable of a range greater than 150 kilometres regardless of payload and to any related major parts and components.

7. The possession and development of missile systems within the permitted range was not prohibited to Iraq but was subject to ongoing monitoring and verification. Consequently, in the period from 1992 to 2003, Iraq continued its work on solid and liquid propellant missile systems. The following are examples of what has been learned from the practical experience of the implementation of ongoing monitoring and verification in the missile area.

8. The range of a missile that is fully developed with a known standard payload can be determined on the basis of flight tests or technical documentation. The determination is easy if the missile clearly exceeds the allowable range by a large margin, as in the case of Scud-B and Al Hussein missiles (which have maximum ranges of about 300 and 600 kilometres, respectively). But if a missile's range is somewhere in the vicinity of the permitted value, then expert evaluation and judgement are required since the results of flight tests may depend on particular

environmental conditions. Such was the case when UNMOVIC determined the Al Samoud-2 missile, which was developed during the period from 1999 to 2002 in the absence of international inspectors, to be a proscribed missile. That determination was made on the basis of the assessment of an international panel of experts that judged the missile to be capable of exceeding the permitted range (see S/2003/580).

9. It is well understood that the range of a missile is affected by the payload. However, a payload may vary depending on military requirements. Thus, it is more complicated to establish the possible maximum range of a missile system under development or at the modification stage, since the results of flight tests would depend on multiple parameters, such as fuel load, payload and engine shut-off (burn time), that could be changed at a later stage and could thus affect the range value. Therefore, range alone is an insufficient criterion to make a judgement on a missile under development. Additional technical parameters applied in the course of ongoing monitoring and verification, that could be practicably verified with a minimal degree of ambiguity, have proven to be effective tools that prevented Iraq from developing proscribed missiles in the presence of international inspectors.

10. These parameters included a 600-millimetre limit for the diameter of the airframe of all liquid propellant missiles, the prohibition of any modifications of SA-2 missiles relevant to their conversion into a surface-to-surface mode, the prohibition of tests of SA-2 engines with shut-off valves or modified for extended flight duration and the prohibition of the use of original or modified parts and components of SA-2 missiles for use in a surface-to-surface role. While Iraq did not formally accept these restrictions, it refrained from the production of missile systems that would violate them in the presence of international inspectors until December 1998, when inspectors withdrew from Iraq.

11. After 1991, Iraq retained capabilities to develop indigenously or modify missiles with a range close to 150 kilometres and, due to the nature of missile technology, was technically able to produce missiles that could exceed the prohibited range. However, it did not do so while under ongoing monitoring and verification. The record of ongoing monitoring and verification in the missile area shows that monitoring goals can be achieved through an enhanced verification system comprising on-site inspections, static and flight test observation, use of remote cameras, documents and computer search, tagging of missile hardware in combination with an export/import monitoring mechanism and restrictions on the reuse of missile parts and components from other permitted-range missiles. The absence of international inspectors, the accessibility of critical foreign missile parts and components, and accumulated experience from past missile projects were crucial contributing factors in the resumption of proscribed missile activities by Iraq in the period from 1999 to 2002.

12. Therefore, the evaluation and research of all aspects of Iraq's past missile projects has proved to be a major condition and prerequisite for the development of an efficient monitoring system capable of identifying critical signs and indicators of proscribed activities.

13. The review of Iraq's missile projects demonstrates that liquid propellant missiles are the most likely candidates for modification aiming at the extension of the range of a missile through a payload reduction and increase of fuel capacity. Parts and components of liquid propellant surface-to-air missiles can also be reused in a surface-to-surface role, like the liquid propellant engines of the SA-2 missiles

used in the Samoud-2 surface-to-surface missiles. Accordingly, it is important to reach a full accounting of all SA-2 missiles and their components, especially engines and parts of guidance and control systems, remaining in Iraq. It should be noted that Iraq was not able to produce indigenously liquid propellant missile engines.

14. Conversely, the example of Iraq's development of the Al Fatah missile (see S/2003/580 and S/2003/1135) demonstrates that solid propellant missile technology is more easily attainable in-country for indigenous production.

Example 3 — Determination of biological warfare agent production facilities

15. In 1991, after the adoption of Security Council resolution 687 (1991), Iraq declared that only one facility at Salman Pak had been involved in biological warfare research. No other facilities were declared in connection with its biological warfare programme. Iraq had decided not to declare the full extent of its biological warfare programme and to remove any evidence of its previous existence, but at the same time to retain all remaining associated facilities, equipment and materials.

16. By 1995, in the course of its continuing verification, UNSCOM collected sufficient evidence suggesting that Iraq's biological warfare programme had not been limited to research activities but had also included the production of several bulk biological warfare agents and, possibly, their weaponization. Consequently, in July 1995, under pressure from the inspectors who had acquired procurement information related to the unexplained import of large quantities of growth media, Iraq finally admitted the past production of biological warfare agents at Al Hakam, a dedicated biological warfare facility. After the departure of Lieutenant-General Hussein Kamel from Iraq in August 1995, Iraq further admitted that biological warfare agents had also been produced at two other civilian facilities, the foot-and-mouth disease vaccine plant at Al Dawrah and the agricultural research and water resources centre at Fudaliyah.

17. The account of international verification in the period from 1991 to 1995 exemplifies that even the most clandestine biological warfare programme, such as the one in Iraq, cannot be hidden in its entirety from a comprehensive inspection regime. It also shows the complexity of the determination of past biological warfare activities and provides lessons that are important to consider in cases when concealment policies and practices are actively employed. Prior to the arrival of international inspectors, Iraq cleaned all sites involved in the production of biological warfare agents, removed evidence of past activities, including relevant documents and records, reconfigured equipment, decontaminated and renovated buildings and structures and prepared convincing cover stories.

18. In May 1991, Iraq first identified Al Hakam as a legitimate biological facility intended for the future production of vaccines or other materials produced by micro-organisms such as single-cell protein. The facility was inspected for the first time in September 1991. Several samples taken by the inspectors from different pieces of equipment at Al Hakam were analysed by one outside national laboratory and were reported as negative for the presence of biological warfare agents. Further inspections of this site took place in 1992, 1993 and 1994. The inspectors raised suspicions regarding the true nature of the site and noticed unusual features of the facility, such as the presence of multiple air defence units around its perimeter, the enhanced protection and bunker-style structures, the separation of different areas

within the facility, the rapid construction of the site, implying a strong sense of urgency, its isolation and secrecy, the presence of equipment that had been transferred from other sites, and the weak economic rationale for the purported production of single-cell protein. Although the inspectors believed that the facility could have been planned as the next stage in Iraq's biological warfare programme, no evidence of its actual involvement in Iraq's past biological warfare programme was found. It was assumed that the very low level of biological containment in the facility prevented it from being used for the production of pathogens and that its equipment was not suitable for such production.

19. It was established that timing was critical for Iraq to eliminate much of the evidence of past activities at Al Hakam. Thus, prompt commencement of verification activities at newly declared or identified facilities is essential, especially for biological inspections. The availability of inspectors for deployment at short notice and well-established analytical capabilities, both within the inspection team and in outside laboratories, are required to achieve this goal. Diversified inspection teams, comprising not only experts in the biological warfare field but also specialists in scientific and technical areas relevant to specific activities such as those declared by Iraq at Al Hakam, namely production of vaccines and single-cell protein, would be required to ascertain whether a facility like Al Hakam fits its declared status and purpose by its design, construction, equipment, staffing, budget, etc.

20. Additional experience gained relates to sampling and analysis, which always carry the notion of scientific argument and thus have a strong influence on a final judgement. While positive results of analysis may provide strong forensic evidence and proof, negative samples may easily lead to wrong conclusions and be exploited by the inspected side. In addition, a limited sampling strategy, focused on a few sampling points, risks missing relevant information and may even be counterproductive. An adequate sampling policy comprising environmental, background and investigation-related points in the vicinity of Al Hakam could have enhanced the chances of detecting proscribed materials in the vicinity. Likewise, the use of more than one laboratory for analysis has a reinforcing effect on the results given. To be effective, sampling and analysis require sufficient preparation as well as a constant update of analytical procedures. However, even extensive sampling and analysis could have produced limited results due to the technical limitations of analytical methods available at that time. Thus, it is desirable to keep samples for a sufficient period of time while new, more sensitive methods of analysis are developed.

21. Considerations related to the low level of biological containment were major factors in the initial perception of the unsuitability of Al Hakam for the production of pathogens. These considerations were drawn from microbiological practices and standards familiar to the United Nations biological inspectors, who were considered to be some of the best scientists and engineers in the biological warfare field. However, they were based on elevated expectations on the part of the inspectors regarding the degree of efficiency of Iraq's biological warfare programme, assuming possible production of viral agents and dried bacterial agents. As was subsequently learned, Iraq produced bacterial biological warfare agents at Al Hakam with a moderate risk of airborne contamination due to the generation of aerosols. Thus, by applying the biosafety standards of developed countries it is not always possible to reach conclusions on the type of biological activities being carried out elsewhere.

22. Unlike Al Hakam, which was built as a dedicated biological warfare facility, the foot-and-mouth disease vaccine plant at Al Dawrah was constructed as a legitimate turnkey facility by a foreign company in the late 1970s and early 1980s. The plant was designed for the production of vaccine for three foot-and-mouth disease strains endemic to Iraq. United Nations inspectors, who visited the plant from September 1991 to 1995, identified capabilities existing at the facility to produce biological warfare agents, but concluded that the site was a legitimate facility since no modifications to its original design had been made by Iraq. No evidence of its involvement in Iraq's biological warfare programme was found until Iraq declared its past involvement in 1995. Sampling at this facility was not performed prior to 1995.

23. The most important lesson learned with regard to the experience of the foot-and-mouth disease vaccine plant is that Iraq indeed carried out large-scale production of a biological warfare agent at a legitimate civilian facility. Conversion of a legitimate facility for biological warfare purposes is difficult to detect, especially when such activities take place only for a short period of time, and when the site requires only very minor adjustments for the production of a biological warfare agent. Similar experience was gained regarding another legitimate facility at Fudaliyah also utilized by Iraq's biological warfare programme.

24. It was also found that if a deception campaign is actively pursued, the probability of finding hard evidence of activities related to biological warfare is minimized. The major technical tool that could have helped to identify such facilities is extensive sampling and analysis. Other verification methods, such as the evaluation of documents and records and interviews with staff, are also important, but could be influenced by deception efforts.

25. It should also be noted that the first teams that inspected facilities at Al Hakam, Al Dawrah and Fudaliyah combined two functions simultaneously — site exploitation and site assessment. It has been determined from this inspection experience that a verification system could be more balanced and effective if it provides for a two-stage approach: verification and collection of facts in the course of inspection activities, and a separate evaluation and assessment in the broader scope of proscribed programmes.